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Attention is called to the "Wants" column. It is invaluable to those who use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

STATISTICS OF THE MISSISSIPPI RIVER.

BY H. L. WHITING, WASHINGTON, D.C.

PERSONS familiar with the range of tide along the seaboard can hardly realize how much the waters of our great interior rivers are affected by the rainfalls and watershed upon and from the vast surrounding valleys. The records of the Mississippi River Commission give much relevant data in regard to these phenomena. The following figures have been selected, from the voluminous reports of the Commission, to give more briefly a knowledge of facts that do not come before the general public. As an instance of the great rise and fall of the Mississippi River at Cairo — at its confluence with the Ohio — in the spring of 1891, at its low-water stage, the surface of the river was within a few inches of the top of the levee that protects the city of Cairo from inundation, and from the deck of the steamer the writer looked down into the streets of the city several feet below the line of the water rushing by with a velocity of nearly seven miles an hour. In the fall of the same year, at the low-water stage of the river, the steamer, at the same place, was fifty-one feet below the elevation at which she floated six months before; and this was not the greatest range of the river at this point.

Difference between highest and lowest water-readings.

Mississippi River.	
St. Louis, Mo	37.1 feet.
Cairo, Ill	53.2 "
New Madrid, Mo	41.4 "
Memphis, Tenn	34.5 "
Helena, Ark	48.0 "
Mouth of White River, Ark	48.4 "
Greenville, Miss	40.8 "
Vicksburg, Miss	51.1 "
Natchez, Miss	49.9 "
Mouth of Red River, La	48 5 "
Baton Rouge, La	36.0 "
Plaquemine, La	29.9 "
College Point, La	23.7 "
Carrollton (New Orleans)	15.9 "
Atchapalaya River.	
Simmsport, La	38.3 "
West Melville, La	30.4 "
Red River.	
Shreveport, La	25.5 "
Alexandria, La	40.2 "
Barber's Landing, La (Head of Atchapalaya)	51.1 "
Arkansas River.	
Little Rock, Ark	31.0 "
Pine Bluff, Ark	29.5 "
White River.	
Jacksonport, Ark	33.9 feet.
Clarenden, Ark	28.8 "
St. Francis River.	
Wittsburg, Ark	44.9 "
Tennessee River.	
Florence, La	30.4 "
Chattanooga, Tenn	54.0 "
Cumberland River.	
Nashville, Tenn	55.6 "
Ohio River.	
Paucha, Ky	54.2 "
Cincinnati, Ohio	69.1 "
Louisville, Ky (Upper)	45.5 "
Louisville, Ky (Lower)	71.0 "

Areas of Overflow.

St. Francis Basin, Commerce, Mo., to Helena, Ark. (east side of river) 6,090	2,874	sq. miles.
(west side of river)	3,216	"
Illinois, Kentucky, and Tennessee	616	"
White and Arkansas Basins (west side of river), Helena to Arkansas City	956	"
Yazoo Basin (east side of river), Memphis, Tenn., to Vicksburg, Miss	6.648	"
Macon, Boeuf, and Tennessee Basins (west side of river), Arkansas City to Red River	4,955	"
East side of river, Vicksburg to Baton Rouge	415	"
Atchapalaya Basin (west side of river), Red River to Bayou La Fourche	6,085	"
Pontchartrain Basin (east side of river), Baton Rouge to Gulf of Mexico	2,001	"
La Fourche Basin (west side of river), Donaldsonville to Gulf of Mexico	2,024	"
	29.790	

Nearly thirty thousand square miles, or three and a half times the area of the State of Massachusetts.

Although, as stated, the high-water depth of the Mississippi River at Cairo is over fifty feet, the low-water depth, on shoals and bars, does not exceed four feet. This great highway to the ocean is, therefore, at these latter seasons, practically unavailable for navigation. Ten of the large steamers of the Anchor Line, which ply between St. Louis and New Orleans, are now laid up, while the elevators of St. Louis have accumulated some nine million bushels of wheat, waiting transhipment.[1] This is but a partial showing of the importance of the improvement of the Mississippi River, in its low-water navigation, the commercial interests of the country; aside from the injury to agricultural interests from the overflow of the lower basins of the river.

ON THE USE OF THE COMPOUND EYES OF INSECTS.

BY R. T. LEWIS, EALING, ENGLAND.

FEW subjects connected with the study of insects have given rise to more widely differing opinions than the rationale of their complex organs of vision, the physical structure of which presents to us one of the most elaborate optical combinations to be found in nature, and this, too, upon a scale so minute as to require no ordinary skill on the part of the microscopist to unravel its marvels.

Attempts to work out the problem as to what is the impression produced upon the consciousness of an insect by an arrangement so complicated have seldom resulted in satisfactory conclusions, not a few failures in this respect apparently being due to inadequately clear conceptions as to the application of the laws and phenomena of refraction to the cases in point. But whether the subject is approached from the standpoint of those who regard an organ as having elaborated itself in obedience to the necessities of

[1] November, 1892.

external conditions, or from the opposite position of those who aver it to have been designedly contrived to meet the special requirements of those conditions, it is a matter for surprise that any should have been found to express a belief that, for distinctness of vision and other purposes for which eyes are required, these specialized and elaborate contrivances are little better than optical failures. Such a notion, if capable of proof, would be a unique exception to that perfect adaptation of means to ends, which, wherever our knowledge is complete, we find everywhere else in nature.

Apart from the question as to whether the nervous structure of an insect's eyes enables it to utilize rays which are beyond the compass of our own, it is clear that the nature of light requires in all organs of vision a structure which is analogous in its optical principles; that is, there must be the means of forming an image, a sensitive screen upon which to receive it, and a connecting line along which the received vibrations may be conveyed to the ultimate seat of the sensorial impressions. Hence we find a lens, a retina, and an optic nerve to be common to all. We may also infer that the external physical requirements will be approximately the same, so that the vibrations must be of proper quality, they must be of sufficient intensity, and they must impinge upon the retina for a sufficient time to enable its sympathetic fibres to respond to and take up the impulses imparted.

The first difficulty which we meet with in approaching the subject is one which does not apply to insects alone, and therefore does not enter exclusively into present considerations.

In the case of human vision the optic angle is so small that each eye sees the same object, indeed confusion is experienced and a double image is perceived unless the optic axes are so converged upon the object as to bring its image upon the correspondingly sympathetic portions of each retina. But in the case of some animals, and in that of birds, the increase of the optic angle precludes the possibility of such co-ordination, so that an entirely dissimilar picture is presented to each eye, and a further complication is introduced in the case of the chameleon, whose eyes are capable of independent movement in every direction within the limitations of their sockets. We are unable to realize in our own minds what the effect of this may be, because, with the exception of impressions received through the sense of touch, we have no analogous experience, but we may readily conceive it to be a matter of interpretation by which the wide extension of the visual field induces the perception of a panoramic view of the surroundings; and if to eyes which are laterally situated we add also others on the vertex, with divergent axes as we find in the ocelli of many insects, we may further imagine that an extension of the panorama vertically may present a picture embracing an area of more than half a hemisphere.

But when we come to regard vision by means of compound eyes, such as we find in insects, other considerations present themselves and it is obvious that the question as to "why and wherefore" requires another answer. I should like to be allowed here to make a protest against the continued application of the term "facetted" to the corneal surface of the compound eye, as conveying an idea which is not strictly correct. At a recent conversazione I found, amongst other objects exhibited, a plano-convex lense, the curved surface of which was ground off into numerous actual facets, and visitors were invited to look through this from its plane face in order to realize the effect produced by the "facetted" eye of an insect. I need not point out that both structurally and optically this conception was entirely erroneous. The structure of the compound eye is, however, now so well known that I do not propose to enter upon it here at any length, but will merely refer to the recent researches of Professor Exner and others as showing (1) that, contrary to previous speculations, it is capable of forming a distinct image of considerable amplitude, towards which each ocellite contributes its share; (2) that in the picture so produced very many of the pictures formed by adjacent ocellites are either superposed or overlap each other in such a way that the corresponding portions of each become coincident upon the retina; and (3) that it is highly probable that the structure of the organ provides an arrangement which serves a purpose equivalent to that of the iris in the vertebrate eye, with the further suggestion of a means of focussing. Professor Exner's experiments also prove that by the intervention of the crystalline cones this composite, or "summation," image is erect, and is formed at an increased distance from the corneal surface.

Those who have access to the last edition of the late Dr. W. B. Carpenter's book, "The Microscope and its Revelations," will have noticed a reference to these researches, but it may be as well to note that the figure on page 908 appears to have been laterally inverted by the engraver, my own recollection and a rough sketch taken at the time enabling me to say that in the original photograph the letter *R* was not reversed as shown in the wood-cut, and the church faced the other way.

Assuming, therefore, that distinct and otherwise perfect vision is enjoyed by the possessors of compound eyes, it is reasonable to suppose that, if we desire to know what is the *raison d'etre* of their complex structure, we shall be most likely to find the answer, if we proceed upon lines indicated by the further assumption, that it is required to meet some special necessity arising from conditions of life which differ from those of other creatures.

Pursuing the inquiry in this direction the following considerations make it probable that such conditions may be recognized in connection with the extremely rapid movements of insects in flight.

The angular diameter of the field of distinct vision in the human eye (as distinguished from the visual angle) is much smaller than is commonly supposed, experiment shows that it varies with individuals, but, for present purposes of illustration, we will call it 10°. The inconvenience which would otherwise arise from so circumscribed an area is in practice largely compensated for by the celerity and freedom of motion common to the eyes and head, by virtue of which also we are able to neutralize the effect of our own movements, and, within certain limits, to perceive moving objects which would otherwise cross the field in less time than the minimum required for the production of a distinct retinal image. The exact duration of this period is a matter of personal equation, but may usually be taken as about $\frac{1}{10}$ of a second. Now it is a matter of common experience that when travelling in a railway train at the rate of, say, fives miles an hour, we can, with fixed vision, clearly distinguish the flowers growing adjacent to the track, but, as the speed increases, we become less able to do so, until, at 50 miles an hour, they cross the visual area too rapidly to leave more than an indistinct impression of horizontal lines. It is, however, conceivable that if, as soon as an object had traversed the field of one lens, it came successively within the scope of nine others, which, without break of continuity, would project its image upon the same portion of the retina, the persistence of the image would be increased tenfold, with the obvious result that the flowers would then be seen as clearly whilst passing them at 50 miles per hour as they would be under ordinary circumstances at one-tenth the speed.

If there is truth in this suggestion, that the use of compound eyes is to enable their possessors to enjoy distinct vision during rapid flight, it would appear to derive support from the fact that we find, as a rule, that in larvæ and in insects which are wingless the eyes are either simple, or that the ocellites, of which they are compounded, are comparatively few in number; whilst in those with wings the compound character is developed to its highest degree in genera whose powers of flight are most remarkable. Instances are not wanting in which the eyes of apterous females are simple, whereas they are compound in the case of the winged males of the same species.

That such extremely rapid flyers as the dragon-flies and predatory Diptera are endowed with acute and accurate powers of vision seems to require no further proof than is afforded by the unerring manner in which they strike and capture other insects which are also on the wing.

PROFESSOR SOPHUS RUGE of Dresden, an authority on matters relating to the discovery and exploration of America, pronounces Mr. Winsor's "Columbus" "the most important contribution that North America has made to the present commemoration" of 1492.